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REFERENCE

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

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v.7-10 no.2

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

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Volume 7 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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WE RESUME

Division of Fire Control, Washington Office, U. S. Forest Service

After nearly 4 years of wartime suspension, FIRE CONTROL NOTES gets back into circulation and will be published quarterly, fulfilling its mission, we hope, even more successfully than before.

About a year ago a special effort was made to resume publication, but the wartime limitations then placed upon the form and content of the periodical would have so changed its character that we decided to wait until better times. Under those limitations, we would have been required to confine the contents to the single subject of fire-control equipment.

Now with a clear green light, we can move ahead with a periodical substantially the same as prewar issues and cover the entire field of fire control with the breadth of expression and subject matter set forth in the text of the flyleaf immediately preceding this article. That statement will, as in the past, express our editorial policy. FIRE CONTROL NOTES will be distributed to a mailing list of about 4,000.

The contents of this first postwar issue have not the diversity we or the readers desire. The articles run heavily to equipment, since for some time it was thought that we would be confined to that category of subject matter. What we lack and badly need are expressions of thought in the whole broad field of fire control—new views on our big, pressing problems and their solution. If articles are provocative and controversial, so much the better. The value of this periodical will be determined by what you and other readers contribute. Something in your fire-control thinking and work is interesting and helpful to others. Write it up and give other men some return for what they have given you.

We have room for long and short articles. Those familiar with the prewar issues will recall the interesting "shorts" which were interspersed throughout the pages. These were brief, compact notes—100 to 200 words—on new and interesting items. They brought sharp focus to limited, though often important, aspects of the fire-control job. We would like more of them.

In setting up FIRE CONTROL NOTES again we have followed closely the original format, arrangement of articles, and character of lay-out, but undoubtedly many readers will have good ideas for improvement and pepping up the style and appearance. We welcome criticisms and constructive suggestions. Special features or departments somewhat in the Reader's Digest style might add interest and liveliness. Perhaps we could run a column on "what's going on" which would carry brief news items on special activities, proposals for new experiments, unusual equipment developments, or even ventures in the realm of "imagineering." It might afford an outlet for what may seem to be wild ideas. A scheme or gadget is seldom practical in its original form, but presenting it in print enables others to help get rid of the kinks and perfect it.

And a final word to contributors. We want your articles and contributions badly, but we make a special plea that you read and follow the instructions on the inside of the back cover as to form and illustrations and save us some headaches. Putting out this magazine is an extracurricular job with us here, and we have neither the help nor time to rewrite, retype, or redraw.

If you really want FIRE CONTROL NOTES, give us all the support possible and we will turn out a creditable periodical whlch fully serves its purpose.

Note to Contributors.—Many contributors or would-be contributors on fire-control subjects may be a little puzzled as to whether to send a prepared or prospective paper to FIRE CONTROL NOTES or the *Journal of Forestry*. Both are now available to them. At the time of the Equipment Committee meeting in Washington, January 1945, a joint arrangement was worked out for insuring suitable outlets for all fire-control subject matter. At that time the proposed Fire Equipment Notes had to be restricted to fire equipment items. Under that limitation it was agreed that there would be a free interchange of papers submitted between the editor of FIRE CONTROL NOTES and the staff of the *Journal*.

The plan was that the broader subjects would be referred to the *Journal*, with perhaps a "brief" covering their content, particularly as it affected fire equipment, to be printed in FIRE CONTROL NOTES. It was suggested, too, that both publications carry cross references on important developments in the field of fire control described in either. The removal of wartime limitations on subject matter for FIRE CONTROL NOTES now changes this situation, and the question of deciding where a contribution should appear will need to be reviewed again with the pending successor to Editor Samuel T. Dana of the *Journal of Forestry*. However, the writer himself can usually decide pretty well if he will keep his audience in mind. The two audiences differ somewhat.

Readers of the *Journal* are interested in forest fire control in its broader aspects, and in new ideas, methods, and equipment which have wide application. However, they are not interested in many of the mechanical details of how things are made or done. The readers of FIRE CONTROL NOTES, on the other hand, are assumed to have a specialist's interest in fire-control techniques and are a better audience for subjects in these categories. A large proportion are field men particularly interested in things they can put to use in their everyday jobs. The publication serves that need. But the editor of FIRE CONTROL NOTES is also very much interested in publishing material on the philosophy of fire control and many broader subjects. The editor of the *Journal of Forestry* is also interested in these subjects and in getting better coverage of administrative and so-called "nontechnical" fire-control material that represents progress and new thinking. In such fields many contributions will be appropriate to either publication.

For the most part, the choice will be left to the writer, but there is no objection to referring any paper to either editor with the request that it be used where it seems most appropriate. In general, a new idea or gadget that has not yet been fully tried out may be reported in FIRE CONTROL NOTES but is usually not regarded as eligible for the *Journal* until some definite conclusions can be drawn as to its field of usefulness. When that stage has been reached, it may be eligible for either, depending on the author's choice with the different audiences in mind. In many cases it will be worth while for articles to appear in both.—A. A. BROWN, *Associate Editor, Journal of Forestry*.

UNIT PROTECTION BY AIR CONTROL

Northern Region, U. S. Forest Service

Smoke jumping was started in northern Washington in 1939. Early in 1940 the new project was moved to Montana and during the succeeding six seasons the activity progressed steadily through the difficult experimental stages into a practical, full-blown operation which now serves parts of Regions 1, 4, 5, and 6. Now comes a new phase of aerial control. The air personnel and facilities are beginning to take over the tasks of patrol and detection in addition to those of suppression. That this has been done effectively and economically for a selected forest area is evident from this interesting account of an important pioneering effort.

A thorough test of airplane detection of fires combined with smoke-jumping patrol has proven successful on some of the most inaccessible areas of the national forests in Region 1.

In former years, control of fires by the use of smoke jumpers has proven economical, but airplane detection was not entirely feasible. This made it necessary to retain a lookout system in every area, even though better and faster suppression could be obtained with smoke jumpers. Thus a duplication or overlap of coverage was required.

The Continental Unit

The region in which air patrol was tried is known as the Continental Unit, embracing 2,054,000 acres of remote and inaccessible forest land in the Lewis and Clark, Lolo, Helena, and Flathead National Forests. Elevation ranges from 4,000 to 9,000 feet along the Continental Divide which runs north and south through the middle of the region. Inaccessibility and the heavy manning required to give adequate ground-crew protection, along with low man-caused fire occurrence, made it an ideal unit for development of fire control by aerial methods.

Forty-three lookout-firemen positions were discontinued on the Continental Unit, and the money was set aside for flying patrol, training smoke jumpers, etc. The objective was to determine whether better protection could be obtained with the same or less expenditure. Nine lookout-firemen positions were retained to give detection coverage to some of the areas of highest fire occurrence, report the occurrence and path of lightning storms, and furnish data from which the Weather Bureau made special daily forecasts.

In the 1945 season, there were 29 fires on the Continental Unit: 18 were class A, 8 class B, and 1 each classes D, C, and E. All but 5 were attacked from the air, and in addition smoke jumpers suppressed one 120-acre fire by ground attack.

Lightning caused 27 of the fires, a camper 1, and the other, a class E fire which burned 2,270 acres on the extreme boundary of the unit, was started by an automobile exhaust during a high wind. Altogether, 2,413 acres were burned, or 0.11 percent of the area in the Continental Unit.

Faster Attack

It is interesting to note that of the 29 fires, 14 were discovered by aerial observers, 7 by lookouts, and 8 by others. Of the fires controlled with less than 10 acres burned, 4 were potentially dangerous. One fire—on which discovery, report, and first action took only 47 minutes by air control—had an average perimeter increase of 4.4 chains per hour in low-low fuels. This fire would have taken ground forces, by conservative estimate, at least 6 hours for the first attack. The wind was 15 miles per hour and the burning index 71 at the nearest lookout.

Another fire on the same day was controlled at 0.2 acres. Action by air took only 30 minutes after the report was made. At least 6 hours would have been required by ground forces.

Airplane delivering smoke jumper by parachute to spot near forest fire.

Two other fires, with a burning index of 100 at nearby stations, were controlled on this day with total burned acreage of 0.05 acres. These would have necessitated at least 5 hours' travel by ground crews, but air attack averaged 2 hours and 30 minutes. And this was longer than the average because only 2 planes were used to handle 6 fires.

Better Protection—Less Cost

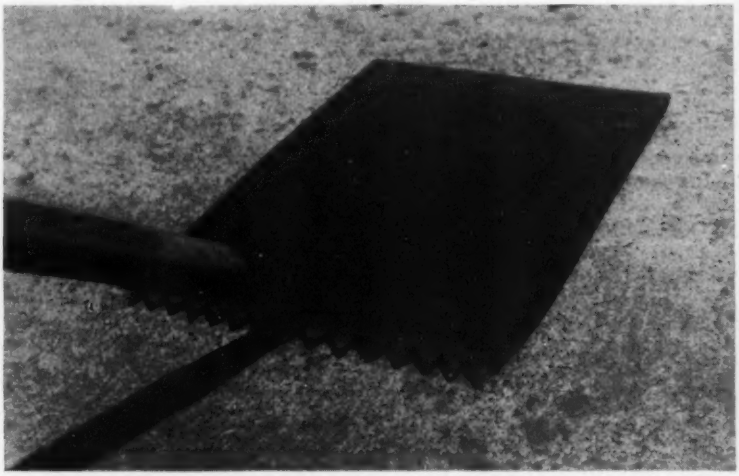
To finance this experiment, allotments ordinarily made to the forests for wages were spent as follows:

Overhead expenses	$6,240
Patrol flying	7,442
Smoke jumpers	4,320
Equipment and supplies	1,434
Subsistence	1,107
Operation of motor equipment	315
Travel expenses	165
Total	21,023

It was demonstrated quite definitely that better protection in such areas as the Continental Unit can be obtained by substituting aerial control for lookout-firemen. At first glance it would appear that no money was saved, but this is far from true. Elimination of 43 lookouts makes it unnecessary to maintain lookout structures and telephone lines and trails to these points. Many other trails and improvements used for fire control alone can possibly be abandoned. There are also other savings, such as reduction in pack stock requirements, overhead for training guards, etc.

It is likely that another unit will be set up in the back country of the Bitterroot, Nezperce, Lolo, and Clearwater Forests.

Special Fire Swatter.—The Blackfeet Indian Reservation fire employees consider the fire swatter their standard tool for control of grass fires. They have found that on many occasions, in order to make the fire line safe, a rake or similar tool was needed to scarify isolated tufts of grass, dung piles, small areas of duff, etc., which were holding fire. Finding it impractical for one fireman to carry both a swatter and rake, a combination tool was made by replacing the rivet bar on the standard swatter with a scarifier made of ⅛- by 1-inch angle iron. Details are shown in the accompanying illustration. To use the scarifier, the handle of the swatter is held slightly lower than the position in which it is held when using the flail.—CHARLES R. GERARD, *Forest Guard, Blackfeet Indian Agency, Mont.*



The Gerard fire swatter, showing detail of toothed rivet bar used as a scarifier.

ADAPTING ARMY EQUIPMENT TO FOREST-FIRE FIGHTING[1]

MAJOR C. A. ROWLAND, JR.

Air Corps, Chief Forestry Section, Eglin Field, Fla.

Major Rowland, a forest officer in Region 8, was commissioned at the beginning of the war and placed in charge of the protection of the large area included in the A. A. F. proving ground in Florida. Due to almost continual aerial practice, testing and incendiary bombardment, the area was a hot one and its protection became a difficult job. In this work Major Rowland was able to secure most of the mechanized units he thought suitable. His adaptations of military equipment to fire-control uses were made with a good sense of design, appreciation of balance and loading limitations, and the best of mechanical workmanship. His experience will be a sound guide when military automotive equipment is finally made available as surplus property.

In June 1940 the Choctawhatchee National Forest in northwestern Florida was transferred to the War Department and became the Army Air Forces proving ground, with headquarters at Eglin Field. This area, of some half million acres of extremely sandy soil, is principally forested with longleaf pine with a scrub-oak understory. The area is characterized by flat ridges which break abruptly to the streams, the majority of which are fed from subterranean sources. On either side of the streams there are comparatively narrow swamps with areas of "flats" adjacent to the larger swamps which are marshy, with a ground cover of wire grass.

Prior to its transfer to the War Department, the United States Forest Service had administered this area since 1909. As fire protection had been practiced for many years, the ground cover and litter became extremely rough and susceptible to fire. The scrub oak, prevalent in the understory, had increased both in size and density because of the fire protection.

Forest fires in this area are almost entirely surface fires, but because of the heavy "rough" and wire grass, there is a rapid rate of spread. It was learned by the Forest Service, that direct attack with water was the best method of stopping the spread of fires here. Fire-fighting technique naturally developed around water-carrying trucks, followed by men to patrol and mop up the numerous snags and debris.

Army Equipment Used

When the War Department took over the area, the fire-detection system was retained and six ½-ton two-wheel-drive pick-up trucks were procured on which were amounted 120-gallon water tanks and Panama fan-belt-driven pumps with the necessary hose and hand tools. These were well-designed units, but with the increase in military operations and the corresponding increase in use of the sand roads and fire lines by heavy trucks, it became impossible to furnish adequate fire protection to the area with these trucks. The fire occurrence was increased by bombing and gunnery missions, despite precautions

[1] Reprinted in slightly condensed form from *Mechanical Engineering*, July 1945.

taken in clearing the ranges and burning off safety zones around them. It became evident that trucks capable of carrying more water, which could traverse the extremely sandy roads and operate on marshy lands, were needed. The fire trucks of the Corps of Engineers were designed for combating structure fires, and the crash trucks were specially designed to fight chemical fires, and regulations prohibited their use for forest fires. The "brush trucks," designed by the Corps of Engineers, were inadequate for conditions encountered, as they had only 2-wheel drive with exposed pumps and fittings which made them impractical for cross-country use. The pumps furnished more water than was ordinarily needed for local conditions, where a small stream of water, which will last for a long period, is of prime importance.

In 1941, several available types of standard Ordnance vehicles were test-driven in an effort to determine the best all-round vehicle to convert to a fire-fighting truck to meet the needs of this reservation. It was found that the 1½-ton, 4 x 4 Chevrolet cargo truck with 7.50–20 tires was the best available vehicle at that time for a heavy-duty forest-fire truck. For a light patrol truck to replace the ½-ton two-wheel-drive trucks originally procured, the Ordnance ½-ton, 4 x 4 Dodge with metal cab was selected. The Panama pumps in use had given satisfactory service, furnishing sufficient discharge and pressure, so these were used chiefly. The first truck converted was a 1½-ton Chevrolet 4 x 4 cargo truck. Seat frames, tarpaulin, and bows were removed and tanks, with a capacity of 500 gallons, and a new Panama pump were mounted on the truck. This unit proved superior to the lighter two-wheel-drive pick-up both in its ability to reach inaccessible places and to carry sufficient water to combat large fires.

The advantages of the Army-type vehicles with their rugged construction and four-wheel drive were obvious, so all the fire-fighting equipment was converted to four-wheel drive, and experiments were made with as many types of vehicles and pumps as could be secured, to determine the most effective combination of chassis, pump, water tank, and nozzles. The original ½-ton pick-ups were replaced by 4 x 4 Ordnance ½-ton pick-ups with 7.50–16 tires, to which the equipment from the two-wheel-drive trucks was transferred. The following report covers the equipment tested.

Chevrolet 1½-Ton Cargo Truck

The first vehicle to be adapted was an Ordnance 1½-ton, 4 x 4 (2–DT) Chevrolet cargo truck with steel cab and body. Tanks having a capacity of 500 gallons were mounted, and a Panama fan-belt-driven water pump with compensating bypass was installed. This vehicle is well adapted for use as a heavy fire truck in making the main direct attack on forest fires encountered in this locality, with the exception of those on wire grass flats. Its power, maneuverability, and water capacity make it the most satisfactory all-round heavy-duty fire truck tested. It is capable of traveling over rough roads and cross country with a full load, except in flats where the muck is so soft that it will not support the weight.

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A similar installation on an identical chassis was made, using a Yale-Towne fuel-transfer pump, operated by a power take-off. This unit gave substantially the same operating efficiency as the preceding unit, the essential difference being the pump. Since the Yale-Towne pump was designed for large volume discharge at low pressure, it refills the tank from natural sources more rapidly than the Panama pump, as two discharge hoses are used simultaneously.

One of the trucks converted was equipped with a winch mounted in front of the radiator, operated by a power take-off. This has proved very effective in enabling the truck to pull itself or other trucks out of sand or mud.

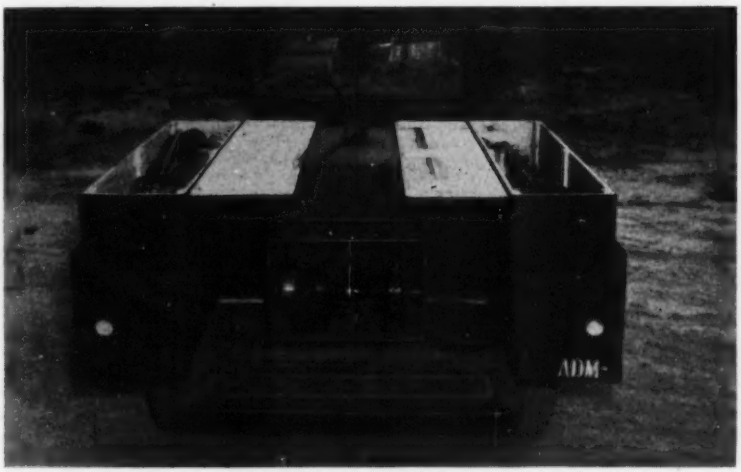
Chevrolet 1½-ton cargo truck showing 500-gallon tank and discharge hose from Panama pump on left front fender. Short hose reduces pressure loss and is adequate for ordinary use; 50 feet of extra hose is carried in truck.

Three-Quarter-Ton Dodge Weapon Carrier

An Ordnance ¾-ton Dodge weapon carrier was converted to a forest-fire-fighting truck by removing tarpaulin, bows, and seat frame and installing a 200-gallon water tank and a Panama fan-belt-driven pump. A metal cab was installed, made of welded tubular steel covered with galvanized sheet iron. Difficulty was experienced in mounting the Panama pump because of the location of the top water-hose connection and generator. This was overcome by making an offset adapter for the base of the pump by bolting two pieces of 2-inch angle iron together, one of which was drilled for the cylinder-head bolts and the other was drilled to match the holes in the base of the pump. This set the pump out 2 inches from the cylinder-head bolts and down 2 inches below the level of the top of the cylinder head and gave adequate clearance between the pump pulley and the radiator hose.

This vehicle handles better than the ½-ton pick-up and its very short wheel base makes it highly maneuverable in the woods. It has ample power, and its large tires (9.00–16) and four-wheel drive give it better traction and more road clearance than the ½-ton pick-up. It is

able to travel in more swampy conditions than can either the ½-ton or 1½-ton trucks. While the ¾-ton truck has been used in primary attack, it has less water capacity than the 1½-ton truck and is better suited as a secondary truck, following one of larger capacity. When the fire weather is not extremely bad, this truck can replace a 1½-ton truck. It is the best all-purpose "light" truck tested. Tests demonstrated that 200 gallons is the largest volume of water that can be mounted on this type vehicle without excessive overloading. With this volume, two extra spring leaves had to be inserted in each of the rear springs. The improvised cab without glass makes it less desirable for the driver because of exposure to heat and smoke, but being open



Dodge ¾-ton weapon carrier. View taken before installation of cab and Panama pump. Tool boxes replaced seat frames. The pumping unit is a type A–6 fuel-transfer unit, used as an auxiliary fire pump.

allows the hose man to operate the hose from the seat. It is not well adapted to the installation of radio because it does not sufficiently protect the equipment from weather.

One-Half-Ton Dodge Pick-Up

The standard Ordnance ½-ton, 4 x 4 Dodge pick-up with metal cab made a desirable substitute for the original ½-ton pick-ups. Tarpaulin, bows, and seat frames were removed from the truck and the equipment was transferred from the two-wheel-drive pick-up with only minor modifications. It performed as well as the original ½-ton pick-up truck, and the larger tires (7.50–16) and four-wheel drive enabled it to operate on terrain on which the 4 x 2 truck could not travel. The rugged construction reduced the damage to the vehicle when traveling through heavy brush to a minimum. This truck handled its load so well that larger tanks were installed with satisfactory results. Although the original tanks had a capacity of only 120 gallons, 175- and 200-gallon tanks were tested. The rated capac-

Dodge ½-ton pick-up truck equipped with 120-gallon tank, radio installation, hand tools, and discharge hose mounted on left front fender.

ity of the vehicle was exceeded, but it was found that good performance could be obtained when a 175-gallon tank made of 3/32-inch sheet iron was installed. The 200-gallon tanks made of heavier material were found to be impractical.

This vehicle is primarily used for forest patrolling and as a secondary truck. Its effectiveness as a patrol truck is greatly increased by installation of a two-way FM radio to keep the dispatcher informed as to the progress of fires and in reporting unusual conditions encountered.

The small water supply limits its effectiveness in furnishing the main direct attack on large fires without support. Its best use in fire fighting has been that of a secondary unit to follow the larger trucks to prevent break-overs or handle small fires which blaze up after the larger trucks have passed. Using the pick-up as a secondary truck reduced the number of men required for patrolling and mopping up fires.

This truck does not have quite the maneuverability or speed of the two-wheel-drive pick-up. As it gets older the steering becomes stiffer and there is more front-wheel vibration, causing greater wear on the front tires. Operating these vehicles on sand roads necessitates frequent replacement of universal joints, particularly on the front drive shafts. The hydraulic-brake tubes are exposed and are frequently damaged in cross-country operation. The truck makes a satisfactory all-round patrol truck, but is underpowered for the job it is performing. The ¾-ton weapon carrier would be a much more satisfactory patrol truck if it had an enclosed cab.

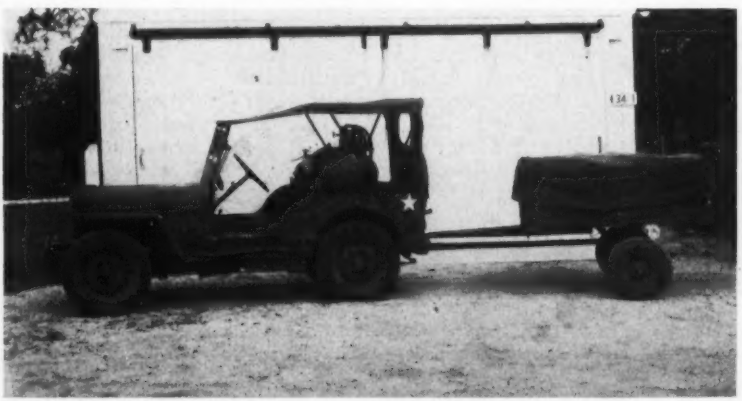
Since the tank capacity is limited, experiments were made with smaller nozzle openings to conserve water. With the 0.25-inch tip, the 120-gallon tanks lasted only 7 to 10 minutes, which is not sufficient time to corral even small fires. It was found that good streams of water were furnished with a properly designed tip having an opening of only 0.14 inch. With this tip, the water supply lasted more than

twice as long and was practically as effective in stopping fires, since increased pressure, created by the reduction of the size of the tip, caused the water to be broken down into finer droplets, approaching fog, which gives more efficient utilization. The small tips so increased the effectiveness of the water supply on the pick-up trucks that they were equipped only with that size tip. The same conservation of water was applied to the larger trucks by equipping each with two tips, the 0.14-inch tip being used on all fires except at the heads of large fires and during conditions which made small tips inadequate.

Quarter-Ton Reconnaissance (Jeep)

The vehicle tested was a standard ¼-ton, 4 x 4 Willys reconnaissance (jeep), equipped with 6.00–16 tires. In converting the jeep to a light fire-fighting and patrol vehicle, a 40-gallon pressure tank, salvaged from a soda-acid fire extinguisher, was mounted horizontally immediately behind the front seats. This location was selected so that the weight would be as far forward as possible to distribute the load. On this tank, a tire-tube valve was installed so that air pressure could be applied to force the water out. In addition, a 15-pound carbon-dioxide (CO_2) cylinder was installed so that the pressure could be maintained as the water was forced out. A valve is located to control the flow of water to a 50-foot ¾-inch hose. The nozzle was reduced to 1/16-inch opening. A pressure gage and pressure-relief valve were installed for safety. The tank can be refilled through the refill opening or by use of vacuum. A vaccum line was run to the intake manifold of the engine, using ¼-inch gasoline-type fittings with ¼-inch copper tubing. A control valve was mounted on the tank and the bleeder valve installed to trap moisture which can be drawn off as necessary. When the vacuum refiller is used, the discharge hose becomes the suction hose.

Thirty-five gallons of water are ordinarily used, allowing approximately a 5-gallon capacity for head space. Pressure on the tank



Jeep and ¼-ton jeep trailer in which Pacific marine pumper, 1,000 feet 1½-inch hose, and accessories are mounted.

is ordinarily kept at 75 pounds, being put in by any air hose or hand pump. As this will not discharge all of the water, the pressure is maintained by periodically opening the valve slightly on the CO_2 cylinder until the operating pressure of approximately 40 pounds is reached. The use of compressed air to build up the original pressure reduces the amount of carbon dioxide needed. Fifteen pounds of carbon dioxide will discharge the tank 5 times. With a nozzle having a $\frac{1}{16}$-inch opening at an average of 40-pound pressure, the water supply will last 40 minutes and produce a thin stream which can be sprayed 35 feet. By using the motor vacuum and the hose without a nozzle, the water can be replaced in the tank by vacuum in approximately 4 minutes under normal conditions.

The jeep has been used for all types of patrol activities and is especially good at reaching normally inaccessible places on the reservation. Its most spectacular use has been as a reconnaissance car for a fire "boss" on large fires from which he can watch the operations and make necessary reconnaissance to determine the action to be taken. With its water tank, it is especially useful in this capacity as it can be used to put out any break-overs that may be encountered by the fire "boss" while on reconnaissance. It is very effective in combating lightning fires as it can reach almost any place, and the amount of water carried is sufficient to handle small fires under normal conditions. It can operate on softer ground than any other vehicle tested. The jeep can pull the 1-ton cargo (tool) trailer or the 1-ton 250-gallon water trailer, but these are ordinarily pulled by ½-ton or larger trucks. It is the ideal vehicle for pulling the jeep trailer carrying the Pacific Marine Pumper. The only difficulty encountered in operating the jeep in thick scrub-oak woods is the damage to the top. However, rips which usually occur near the bows can be easily repaired by a shop equipped to handle canvas.

Trailers

The large acreage of land under protection made it desirable to motorize all fire-fighting equipment possible. In order to make fire tools and special equipment readily available for dispatch, use was made of Army-type trailers. All of the trucks are equipped with trailer hitches, so towing presented no problem.

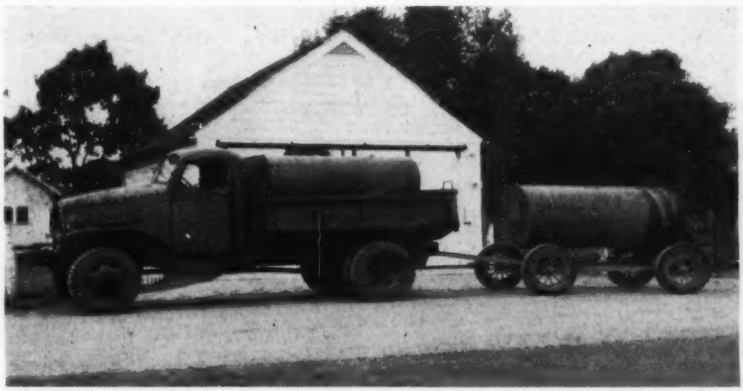
The Nash-Kelvinator 1-ton, two-wheel cargo trailer made an excellent portable fire-tool box. Three of these units were equipped and located at strategic places for most efficient use. Each was equipped with a complete assortment of hand tools for 50 men. All tools have distinctive markings so they can be replaced on the proper vehicle after use. These kits have saved much lost time in handling tools, and immediately after fires they are made ready for future use. The tarpaulin and tool boxes on the trailers protect them from damage or weather. The 50-man kit consists of the following tools:

10 rakes, asphalt.
10 hoes, council.
15 shovels.
2 saws, cross-cut.
4 axes.
4 pumps, back pack.
4 lanterns, kerosene.
1 burner (back-fire torch).
1 pair snaking tongs.

The 1-ton, 250-gallon Lavine two-wheel water trailer has been used without change as an auxiliary water supply to refill fire trucks and

furnish drinking water to fire-fighting crews. In cases where fire fighting was on open land, or where buildings or targets were protected, these trailers have carried an auxiliary water supply directly to the fire behind pick-ups and, when the tank supply of the pick-up was exhausted, the water was pumped from the trailer directly onto the fire by use of a long suction hose from the pump to the trailer.

The 750-gallon four-wheel trailer tank is used as an auxiliary water supply on large fires and to furnish water for the Pacific Marine Pumper when it is operated away from a natural water supply. Use has been made in refilling fire trucks at fires, where the water is pumped from the trailer into the truck by a No. 325 engineer brush



The 750-gallon four-wheel trailer tank drawn by 1½-ton truck.

truck, the Pacific Marine Pumper, or type A–6 fuel-transfer unit. This trailer has been used, towed by a 1½-ton cargo truck, in protection of buildings or targets, by installing the Pacific Marine Pumper in the bed of a 1½-ton cargo truck and pumping water from the trailer.

A type A–6 fuel-transfer unit has been mounted directly on this trailer to increase its efficiency in refilling trucks. The unit has a large volume discharge, which enables it to pump considerably more water than the pumps on most of the trucks.

The ¼-ton jeep trailer, which was originally designed as an experimental trailer for use with the ¼-ton reconnaissance car (jeep), has been adapted to use as a carrier for the Pacific Marine Pumper, its fittings and hose. The sides and gates were made of plywood and the containers for the pumper and 1,000 feet of hose can be removed from the trailer. Wooden cleats were fastened to the floor of the trailer to hold each box in place. A cover was made for the entire trailer and its cargo and no other adaptations were necessary.

Mobile Fire-line Plow Unit

The Mathis two-disk fire-line plow is the best tested for this area. Used with the International tractor, T–6 or T–9, this plow makes a very efficient unit for fire-prevention and fire-suppression work. On fire-prevention work, the T–9 tractor is more desirable as it has more

power and wider tracks which enable it to plow lines faster and farther into the edges of the swamps and on more marshy lands. The T–6 proved to be a more desirable tractor for use with the Mathis plow in fire-suppression work. It can be transported on a 2½-ton truck, which carries skids and pulls the Mathis plow mounted on pneumatic tires. On suppression work the plow can be disconnected, the tractor unloaded and rehitched to the plow and ready for use in 7 minutes.

On fire suppression, this plow has been most effective when following one of the larger water trucks to plow a line around the fire at the edge of the burned area. This greatly reduces the number of men required for patrol and mop-up. The plow is also used to prepare lines from which backfire can be started safely and to reach places which are inaccessible to the trucks. In wire grass it is often possible to stop fires with a plowed line, in places where trucks cannot always be operated.

International T–6 tractor and bulldozer loaded on 2½-ton G. M. C. cargo truck trailing Mathis two-disk fire-line plow.

Specifications of Equipment Tested

	1½-ton cargo truck	¾-ton weapon carrier	½-ton pick-up	¼-ton jeep
Make	Chevrolet	Dodge	Dodge	Willys.
Capacity tons	1½	¾	½	¼.
Driving wheels	4 x 4 (2–DT)	4 x 4	4 x 4	4 x 4.
Tire size inches	7.50–20	9.00–16	7.50–16	6.00–16.
Pump	Panama and Yale-Towne.	Panama	Panama	Compressed.
Tank capacity gallons	500	200	120–175	40.
Hose, discharge inches	¾	¾	¾	¾.
Hose, suction inches	1	1	1	¾.
Nozzle tip inches	0.20 and 0.14	0.14	0.14	0.07.

SMOKE MASKS AND GOGGLES

OLEY SCOTT

Mark Twain National Forest, U. S. Forest Service

Almost everyone with experience on the fire line remembers instances where a flare-up might have been handled and the break-over prevented if the crew, or only one good fire fighter, had kept on pitching even for a fraction of a minute. But the eyes and lungs couldn't take the acrid smoke any longer. The devices here described are not burdensome or hampering, and if they were more generally used, probably much less lost line would be reported.

In 1942, experiments were begun on the Mark Twain National Forest with the use of smoke masks and goggles by fire crews on close-in work on hot-spotting, burning out, or holding oncoming fire at a road or natural barrier.

The light fuels of oak leaves and grass had so much increased under protection that it was difficult to construct and hold a fire line on the higher danger days when the rate of spread was rapid because of strong and frequently shifting winds. Often, because of heat and smoke, crews had to fall back, with consequent loss of fire line, increased burned acreage, and discouragement of the fire fighters.

Various types of gas masks, respirators, and goggles were used experimentally. Trials showed that the smoke masks and gas-proof goggles permitted fireguards and fire fighters to hold a fire under conditions that would be intolerable without such protection from smoke and heat. It was found that protection of the eyes is as important as of the nose and throat and therefore the goggles must be gas-proof.

Standard Equipment

The smoke mask and gas-proof goggles are now accepted as standard equipment for fireguards and initial-attack crews on the Mark Twain Forest. Seasoned guards carry their masks at all times when on fire duty. Local crewmen who are repeatedly called to fight fires request this device as part of their equipment when hired for fire-suppression work.

When not in use, the mask is suspended around the neck and the goggles are pushed up on the head. It takes but a few seconds to adjust the device, which can be readily removed from the face when not needed.

Several types of masks and goggles that may be used in fire fighting are manufactured. The Mark Twain Forest has experimented with and found quite satisfactory Carter's combination gas mask and goggle and Cover's new gas mask and gas-proof goggles. Cover's goggles have a very effective device for preventing the lenses from fogging up. Each eye piece has a water chamber that should be kept filled; a nod or shake of the head clears the glasses of moisture.

The Army goggle M–1944 is now being tried, but until it is used more extensively on actual fires, no definite recommendations can be made.

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HELICOPTER HOPES FOR FIRE CONTROL

DAVID P. GODWIN

Assistant Chief, Division of Fire Control, Washington Office, U. S. Forest Service

It's an exciting field of thought—the employment of helicopters in fire control and other forest activities. Hopes long cherished but often dim are being renewed as technological advances take on the shape of reality. As the development of the hovering type of flying machine—known to the aeronautical profession as rotary-wing aircraft—moved forward by slow and painful steps, foresters began to dream of the revolutionary effects it might have upon their present ways of doing the field job. It seemed like a vehicle built to order. In the early 1930's we had a few opportunities to use the autogyro over some of the western areas. But the autogyro was a transitional type and did not free itself of the basic elements of the airplane. Now comes the helicopter.

Development of the Helicopter Principle

The pure helicopter principle has engaged scientific thought for centuries—Leonardo da Vinci designed one in the fifteenth century. But he, like hundreds of successors in this field, failed because of the lack of a sufficiently powerful force to lift or propel the machine. So it was not until well after the invention of the gasoline engine and some years after the first airplane flights that rotary-wing aircraft left the ground. In 1922, Bothezat, a Russian scientist, under contract with the United States Army, built his helicopter and made several short but successful flights. This was the real beginning of the practical development. The autogyro entered the field for a period and then under an appropriation from Congress in 1938, the Army Air Forces—acting for the military branches and a few civil agencies (including the Forest Service)—invited bids for design competition. Later, out of this action came the Sikorsky helicopter. In 1942, the Sikorsky XR–4 made its first flight and was the forerunner of the many war-inspired helicopters now in the air and performing, in the main, like grown-up airships and not toys.

During the past 2 or 3 war years there has been a ferment of design and production activity in this aircraft field, and now it is accelerated by the race to reconvert to peacetime requirements and compete in the commercial market just around the corner. Today there are about 50 aircraft organizations engaged in the manufacture or development of helicopters. This dramatic new development in air travel has excited the public interest; and due to Sunday-supplement articles, semiscientific magazine promotion, and the zeal of advertisers' artists, the whole thing has been overpromoted. Many people look forward confidently to buying soon a two-passenger job for about the cost of a flivver, or a chance to ride in a 50 passenger airline helicopter. For such people disillusionment is ahead.

Developments have reached a stage, however, where it can be said that the helicopter is the most versatile type of flying machine known to man, capable not only of vertical rise and descent within an area slightly larger than that swept by its rotors, but also of hovering, climbing, gliding, and flying forward, backward, or sideways.

Uses in Forested Areas

Because it can land and take off in very restricted areas, the helicopter could deliver men and supplies in thousands of spots throughout forested areas, such as flat ridge tops, small meadows or clearings, and in canyon bottoms. The Forest Service, if sufficient funds were provided, could extend the number of airplane landing fields beyond the approximately 90 now in use on the national forests, although topography would soon limit the number of available sites. Furthermore, the clearing and leveling of such sites is an extremely costly process. On the other hand, if perfected rotary-wing aircraft were available, there would be almost no limit to the number of small landing spots already provided by nature or which could be inexpensively prepared. With such an air-ground transit system, small well-trained and equipped crews could be transported to spots at or near small fires very quickly after discovery and report.

The helicopter would also have many other forest uses. On large fires men could be shuttled back and forth between fire camp and fire line, and prepared food taken to the fire fighters on the job. For various types of observation such aircraft has no equal. These include detection of fires, scouting project fires from the air, and prevention and law enforcement in areas where incendiarism gives trouble. Helicopters would be ideal for search and rescue work, livestock and game counts, and for survey and administrative travel in connection with range and timber management.

Most of the federally protected forest areas lie in the western mountains and are rough and relatively inaccessible. Millions of dollars have been invested in roads and trails constructed primarily and in some cases purely for fire protection. The large annual maintenance cost of these ground-transportation systems is an additional financial burden. A well-planned and skillfully managed helicopter operation conceivably could provide a degree of protection justifying a reduced road-building program and abandonment of some existing routes.

Given certain assumptions as to helicopter performance, such as pay load, hovering and service ceilings, cruising range, speeds, and operating costs, it should be relatively easy to prepare a helicopter fire-control plan. Actually, several of our western regions have selected sample areas and worked out on paper and maps the location of hub or operating points, degree and time of coverage, suitable dispatching schemes, the elimination of existing facilities and personnel, and have set up rough comparisons of the costs of the respective systems.

Prospective Designs

The aeronautical principle of the helicopter has been proven beyond doubt, but mechanically there is a different story. Much has yet to

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be done to remove the "bugs" from the complex mechanisms. Corrections and refinements must come in rotor-blade construction, power transmission, and the hub design and assembly, and lighter and stronger metals must be employed. Another important and interesting time-taker in this feverish evolution is the matter of arrangement and number of rotors, which the aircraft designers call "rotor configuration." A struggle is on between the advocates of these different helicopter conceptions. A great number of configurations have been worked on, but basically there seem to be about a dozen. No doubt these will shake down to less.

We laymen are easily lost in these aeronautical competitions and prophecies as to which rotor schemes will survive, but it is possible to state oversimply what the present outstanding patterns are. There appear to be about six: (1) Single rotor with tail rotor to counteract torque as in the Sikorsky helicopter; (2) two rotors mounted on either side of the fuselage but clearing as exemplified by the Platt-LePage machine; (3) two rotors mounted on either side of the fuselage but synchronized and intermeshing as demonstrated by the Kellett design; (4) two rotors mounted in tandem (fore and aft) but clearing as illustrated by the Piasecki; (5) two rotors mounted in tandem but overlapping in sweep as exemplified by the Magill; (6) two coaxially mounted rotors (one superimposed above the other) as in the Hiller or the Bendix.

Together or singly, P. A. Thompson and I have visited the plants of six leading helicopter manufacturers to make a rough survey of the progress being made, to discuss with these men the possible forest uses of rotary-wing aircraft, and to fly in some of the models. Also, for a long time we have had contract with industrial designers and

The Kellett military model helicopter XR–8, which employs two 3-bladed intermeshing rotors

Sikorsky military helicopter R–5 which, with enlarged cabin, will be the basis for the Sikorsky commercial four-place model.

engineers and with officers of the Army Air Forces helicopter development section. We have familiarized industrial producers with our fire problems and fire-control methods which we believe the helicopter can improve upon, and invited them to demonstrate—under flying contract if necessary—what these machines can really do in the actual ground and air conditions presented by our rough mountain terrain. One or more will probably respond to this invitation during the early summer of 1946.

As is generally known, the three Sikorsky models were the only helicopters produced in quantity for the A. A. F. As roughly graded by their power, these are the R–4, 180 horsepower; the R–6, 235 horsepower; and the R–5, 450 horsepower. Several hundred of these were built and flown. The R–4 is a very light reconnaissance type and hardly suitable for any western forest work. The R–6 may have some applicability, but the R–5 is the most powerful, has fine performance, and is the prototype upon which the first Sikorsky commercial model, the S–51, will be based. The following data on the S–51, which will probably be produced in moderate quantity in 1946, help to visualize what the machine is like and can do:

Performance

(In NACA Standard Air)

High speed at sea level	miles per hour	103
Cruising speed at 65 percent brake horsepower	do	80
Minimum flying speed	do	0
Maximum rate of climb at sea level	feet per minute	1, 200
Hovering ceiling	feet	3, 500
Service ceiling	do	13, 000

Fuel consumption (cruising) approximate 28 gallon per hour.

Load Distribution

(Cruising range 150 miles)

Fuel (70 gal.)	pound	420
Oil (6.7 gal.)	do	50
Residual fuel and oil	do	30
Pilot (1)	do	170
Passengers (3)	do	510
Baggage	do	70
Useful load	do	1, 250

Weights

Gross weight (design)	pound	4, 900
Useful load	do	1, 250
Empty	do	3, 650

Changing the employment of this useful load to a distribution more suitable to our fire-suppression crew needs, the 500 pounds of fuel could be reduced to 350, thus releasing 150 pounds to be devoted to personnel and equipment. This would cut the cruising range down to about 100 miles but would permit the transportation of four men (including pilot) and 220 pounds of equipment. This is merely an example and leaves out of consideration the flying, hovering, and landing problems inherent in altitude.

The Piasecki PV–3 is, to my knowledge, the largest American helicopter. Its fuselage is 48 feet long and according to Mr. Piasecki it has flown with 10 passengers—unusual lift for a 550-horsepower engine. The model has been accepted by the Navy. Equal or greater weight-carrying capacities, we learn, are being projected by other builders. The biggest job we have heard of is the German helicopter, Focke-Achgens, powered with two 2,000-horsepower engines, which was in development during the war and the design of which was discovered and reported by a British Intelligence Mission. It was to mount two 55-foot rotors laterally, weigh 16 tons, lift 5 tons, and was intended to carry tanks and trucks across rivers and to hoist such loads as bridge girders into place.

Costs

What will helicopters cost? We ask that question frequently but there is no definite answer. It is quite understandable that manufacturers can as yet set no prices. Great expenditures for research and engineering have gone into present models which have been virtually hand-made. Even though all makes still have "bugs" to be worked out, it is likely that three or four leaders will go into moderate commercial production sometime in 1946 and at that time will quote. As production progresses, costs will decline and probably reach a point where helicopters can be had for prices 30 to 50 percent in excess of airplanes of equivalent pay load and other comparable characteristics. The difference in cost between the two types of aircraft will be the price that customers will have to pay for the unique performance which can be had in no other way. Because of the helicopter's inherently intricate mechanisms and vulnerable members, it is likely also that operation and maintenance costs will exceed somewhat those of comparable airplanes.

Helicopter pilots and mechanics are specialized, and due to the newness of this technology, few in number. They will come from the personnel of the Army or the manufacturers. In the whole country there are probably not 200 competent pilots. However, there is a surplus of airplane pilots, and questioning a number of authorities turns up a sort of average opinion that 30 hours of training is sufficient to make a helicopter pilot of a capable airplane pilot.

Tests in National Forests

We now have high hopes for an early comprehensive field program of test and demonstration of the adaptability of the helicopter to forest work under actual forest conditions. Last summer and fall many contacts were had with officers of the A. A. F. relative to the Forest Service proposal of military aid during the 1946 season, involving an experimental as well as operational project. The experimental project will include two phases: (1) Experiment and test to develop, if possible, a technique of effectively dropping fire-suppression materials from airplanes and (2) test and demonstration of the suitability of helicopter operation as a part of the fire-control system. The latter only is pertinent to this article.

The whole plan was approved October 23, 1945, and a directive was issued by the Assistant Chief of Air Staff, assigning to the Continental Air Forces the task of setting up the projects as a cooperative endeavor with the Forest Service. For the helicopter project March Field in Southern California was selected as the center of operations, and the Angeles National Forest as the proving ground. In December 1945, two R–6 machines with crews were assembled at March Field and at this writing four more R–6's are due to arrive and two R–5 machines are expected to be assigned. These are, of course, the military types but will serve fully to demonstrate the adequacy of helicopter performance under those conditions.

The work plan provides for a series of tests to determine the limits of combinations of conditions, including load, topography, altitude, weather, and cover within which satisfactory performance can be obtained. These will be combined with or followed by tests of practical application of the helicopter in the many and varied proposed uses in Forest Service work. The results of these operations, which could be provided us only by the A. A. F., should put us far ahead in our knowledge of how we can employ this new scientific development.

So far helicopters have not flown our forested areas. Flights in a few comparable conditions have been cited, but comparisons and simulations are not definitive; and until these airships maneuver over our actual terrain and do the things we require of them, we will not know. The first tests with existing models may not be entirely conclusive, but if they are only fairly successful, we feel confident that in a reasonably short time the pending improvements in the mechanical elements will round out a vehicle that will mark a turning point in the progress of forest transportation.

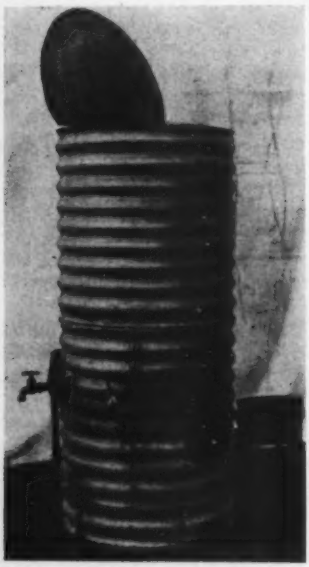
PORTABLE WATER HEATER

CURTIS E. PRICE

Forester, Siskiyou National Forest, U. S. Forest Service

The Siskiyou National Forest has tried a number of water heaters and, for use at large camps, has settled upon one made from culvert material which can boil 60 gallons of water in 35 minutes from the time of filling. Ordinarily, with most heaters it takes an hour to boil 60 gallons.

The heater is made from 24-inch culvert material and weighs a little over 100 pounds. The seams are welded and a partition, which serves as the top of the firebox and the bottom of the reservoir, is welded in. The total height is 56 inches, and the top of the firebox is 20 inches from the ground, which serves as the firebox floor. A notch 3 by 6 inches is cut at the bottom for draft. A fuel door 7 by 10 inches is cut near the top of the firebox and hinged as indicated. A collar is welded to the upper edge of the firebox at the rear to take a 6-inch stovepipe elbow. Three joints of pipe are ordinarily used. The top of the reservoir is closed with a hinged lid to keep out leaves and trash.



View of portable water heater, showing fuel and draft openings, carrying handle, faucet, cold water pipe attachment, and stovepipe elbow.

A total of 28 feet of ¾-inch pipe is used in making the coils. Three turns around the firebox are placed between the draft opening and the fuel door, and six lengths across the back half of the top of the firebox. Return bends are used in making up the latter and the lengths are, of course, progressively shortened as the side of the cylinder is reached. The cold water attachment to the coil enters the reservoir just high enough to clear the bottom.

The hot water entrance to the reservoir is 8½ inches above the bottom. Its location would not seem to make any difference, but Al Love, who designed and constructed the heater, says that after considerable experimentation it was concluded that heating efficiency was greatest with the location as indicated. Various lengths of coil were tried, and the arrangement described gave the best results.

DDT—FIRE-FIGHTERS' FRIEND?

H. T. Gisborne

Northern Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service

Can DDT, the new miracle insecticide, make living conditions more pleasant and healthful around fire camps? That is the question Region 1 set out to answer last winter.

Early in April 1945, 5 pounds of the powder was distributed by the region to several national forests with instructions for its preparation (solution of 1½ ounces of powder in 1 quart kerosene) and use. The plan provided that each forest in April or May count the number of flies, yellow jackets, mosquitoes, etc., found at each of two cookhouses or bunkhouses in a given locality; spray one unit and leave the other untreated; and report on form sheets the numbers and classes of live insects found 1, 2, 3, and 4 weeks after spraying.

Although the results were insufficient to warrant generalization, primarily because April and May were exceptionally cold and there was an abnormally scanty insect population at most stations, the possibilities of DDT as a friend of fire fighters were indicated.

Treated and Untreated Rooms

The report from Spotted Bear Ranger Station is typical. Before spraying, there were 20 live insects in the unit treated. One week later, there was none; 2 weeks later, one; after 3 weeks, none; and after 4 weeks, two. By contrast, in the untreated room there were 18, 24, 20, and 25 live insects after a lapse of 1, 2, 3, and 4 weeks, respectively.

Supplies of DDT powder were later furnished to several forest officers for use at fire camps. The one report received was highly complimentary but indicated that after 4 or 5 days less effect was apparent. This means either that the initial spraying had been inadequate or that the presence of a fire camp brings a very material influx of flies.

Tests were also made at two lookout stations, where flies and flying ants are sometimes a great nuisance. Results from merely wiping the sills and rails of the windows were remarkably good. One of the rangers immediately asked for enough DDT to treat all of his lookout houses next year.

No harmful effects have been observed in handling DDT, although at least one man has had his hands thoroughly covered several times by the dry powder.

GRAVELY FIRE-LINE BROOM

ALBERT HOWARD

General District Assistant, Houston Ranger District, Mark Twain National Forest

The Gravely tractor with rotary broom attachment was tried out on line construction in leaf-type fuels during the spring fire season of 1945 on the Houston Ranger District, Mark Twain National Forest, after original use on the Shawnee National Forest. Considerable information was obtained and definite conclusions reached which are of value in the future use of this piece of equipment.

Description of Tractor

The Gravely tractor, manufactured by the Gravely Motor Plow & Cultivator Co., Dunbar, W. Va., is a small two-wheel rubber-tired garden-type tractor, with five or six different attachments, such as plow, mower, rotary broom, etc. The broom consists of ten 24-inch sections of 6-inch fiber brushes, having an over-all width of 33 inches and diameter of 16 inches. It has a high and low rotary speed. Power is furnished by a 5-horsepower, one-cylinder, air-cooled motor. The tractor has two speeds forward and one reverse; over-all length is 92 inches and height to handle bars 40 inches. It operates on two wheels with rubber tires size 4.00 x 8. A walking operator handles the controls.

Use In Fire-Line Construction

During the 1945 spring fire season, this unit was used on initial attack on two class "C" and three class "B" fires. The crew on three fires consisted of one man in front with the rotary broom and two following to clean and widen the fire line. On two fires, the crew comprised five men, a boss, one with rotary broom, two cleaning and widening, one back-firing, and two patrolling and scouting. The indirect method of attack was used on all fires and rate of spread determined the distance between line and edge of fire.

The machine was used in four different fuel types:

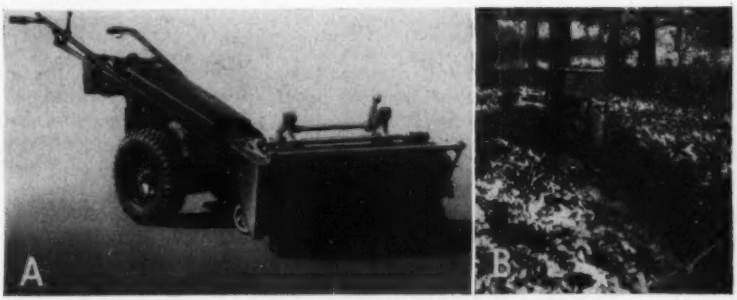
(1) *Short grass and weed fields.*—Here it was of no value because the rotary broom sweeps only loose material, such as leaves, and does not dig into the soil, as is necessary in grass. It simply bent the grass over, but did not clear any line.

(2) *Dense southern hardwood reproduction.*—In this type its use is limited, owing to the difficulty of maneuvering the machine through dense reproduction, but more particularly to the broom's inability to sweep a clean line. Short stubs are left from line clearing.

(3) *Fully stocked upland hardwoods and hardwood-pine types.*—Performance of the machine in this type was considered satisfactory. Line constructed was equal to four well-trained men with hand tools.

(4) *Upland open southern hardwoods.*—Here the Gravely broom made an excellent showing. The line constructed was down to mineral soil, and no cleaning with hand tools was necessary. It was possible to construct as much as 60 chains an hour with an estimated average of 30 chains per hour for all fuel types except grass fields.

The Gravely fire-line broom was used on slopes varying from 0 to 25 percent. Effectiveness on slopes above 15 percent was noticeably reduced when using rubber-tired wheels, due to lack of traction rather than lack of power. However, new cleated steel wheels have been purchased which it is believed will increase the unit's effectiveness on steeper slopes.



A: View of Gravely rotary fire broom. Note covered chain drive. F-433130.
B: Fire line, 18 inches wide and 90 percent clean, built by Gravely rotary broom in leaf fuels. F-433135.

The Gravely broom is easily loaded and unloaded by using two wooden runways and driving it into the pick-up under its own power. No great mechanical skill is necessary to operate and maintain it. Nor does it require much training to make a satisfactory operator out of the average fire fighter. Because of the shortage of fire fighters it was a very valuable tool during the past season.

Possible Improvements

Several possibilities are to be explored in improving the Gravely broom. An intermediate speed between high and low now available seems necessary. Some testing of wire or steel brooms, as against the fiber broom, also is desirable. Dirt and other debris cast up by the broom are thrown into the drive chain and gear, which should be moved to the other side of the machine.

TRAINING IN FIRE-FIGHTING TACTICS[1]

GLEN R. DURRELL

Director, Division of Forestry and State Parks, Oklahoma Planning and Resources Board

Here is an idea that can make training in fire tactics and fire strategy a lively and stimulating game. Every trainer would want to develop it a little differently to fit the particular needs of a specific group. But it has some elements that could be adapted to a variety of fire problems. Since it is essentially a graphic method, the description here cannot give a very complete picture of it. The author has agreed to send a limited number of samples of the cards and other devices he uses to readers particularly interested, in order to help in this respect.

In recent years there has been a steady advance in methods of constructing fire-control line, in equipment, and in training programs to increase the efficiency of the fire fighter in the production of held line. These are techniques that can be demonstrated, practiced, and used.

Our efforts at training in tactics and in fire-fighting generalship are largely confined to discussion, to analysis of disastrous fires, and to the school of experience. There is, of course, no substitute for experience, but when experienced men are not available it is obvious that we cannot set fires of the type our fire bosses must learn to handle in order to give them the necessary training.

Tactics Analyzer

To help meet this need in our Oklahoma organization we have developed what we call the fire-tactics analyzer. Expressed in simple terms it consists of plotting alternately the increment of the perimeter of a fire and of the control line by 15-minute periods.

Two rate-of-spread scales have been prepared for each fire-danger class; one for the burning period, the other for the night period. These scales show the spread of the head, flank, and rear of the fire by 15-minute periods. For a given fire-danger class in our particular area, slope is the principal factor affecting rate of spread. Therefore the scale is calibrated to show the distance the fire would travel down a steep slope, down a moderate slope, on the level, up a moderate slope, and up a steep slope for head, flanks, and rear in 15 minutes.

Another set of scales shows the amount of line that can be constructed in a 15-minute period by crews of various sizes, by direct and indirect attack, and by the various types of power equipment in use. Scales also show backfiring rates for trails and streams and for day and night travel for men and equipment, on trails and in the woods. For convenience, all scales are plotted on a basis of 16 inches to the mile. For training purposes, these scales were mimeographed on cards which show map distances in feet. A separate card was made for each danger class with the scales for daytime on one side,

[1] Reprinted from *Journal of Forestry*, February 1945.

and for night rates of spread on the reverse. Separate cards were made for each of the line-construction methods, for backfiring, and for rates of travel. This diversity allows the fire fighter to use only the scales applicable to the problem at hand. For office use we find it convenient to scratch all of the rate-of-spread scales on one sheet of celluloid and the line-construction scales on another.

How the Device is Used

To use the device we first select the section of land on which the fire is to occur. We then refer to topographic and fire-control maps, and make a drawing of this section on a scale of 16 inches to the mile, using standard colors to show all contour lines, roads, trails, streams, and any other features that might affect the spread or control of a fire. A set of conditions is next agreed upon, including point of origin, time of day fire started, class-of-fire day, wind direction, elapsed time from start of fire until crew arrives, size of crew, and power equipment available. The proper rate-of-spread scale to fit these conditions is selected and the fire area is plotted in red lines on the map by 15-minute periods to represent its size and shape at the time the crews arrive.

The fire fighter then studies the problem on the map, selects a point of attack, and using the proper scales, draws in with a green line the amount of control line he could construct in 15 minutes with the number of men and the equipment assigned to him. The fire is then expanded by 15 minutes and the next 15 minutes of control line drawn in. This alternate drawing of fire line and control line continues until the fire is surrounded. (To plot the fire accurately at each 15-minute period, place a dot at frequent intervals out from the periphery, according to the slope on the map and rate of spread as shown in the applicable scale, then extend a line through all dots, thus establishing a new periphery.)

Rate of line construction in 15-minute intervals with indirect attack.

The burned area and the length of time required for control are then calculated. At this point the fire fighter behaves just as he does in the woods; he mops his brow and breathes a sigh of relief.

The lesson has just started, however. This is the time to discuss "What would have happened if." If line was lost through failure to tie down one end, by poor distribution of strength, by failure to start the control line far enough in advance of a rapidly spreading fire, or for other reasons, the cost of the error is determined by replotting the control line on the same diagram, and the difference in area burned and time required are calculated. If no line was lost, alternate points of attack or distribution of strength may be plotted to demonstrate better methods. On other diagrams the cost of excessive

HEAD FIRE

——0
——Steep Down, 59 ft.
——Moderate Down, 118 ft.
——Level, 198 ft.
——Moderate Up, 279 ft.
——Steep Up, 396 ft.

FLANK FIRE

——0
——Steep Down, 23 ft.
——Moderate Down, 47 ft.
——Level, 79 ft.
——Moderate Up, 119 ft.
——Steep Up, 158 ft.

REAR FIRE

——0
——Steep Down, 18 ft.
——Moderate Down, 35 ft.
——Level, 59 ft.
——Moderate Up, 89 ft.
——Steep Up, 118 ft.

Rate of fire spread in 15-minute intervals on a class-3 day, 10 a. m. to 6 p. m.

elapsed time can be indelibly impressed, as can the value of extra men and equipment. This kind of a session can be held on every fire fought on paper. The answers are positive and impressive.

Two general rules are followed in plotting the fire and control lines. First, tactics or equipment must not be used on paper in situations where it would be impossible to use them under field conditions. Second, the answer to almost all other questions that will arise depends on what the fire or the fire fighters would do in similar circumstances in the field.

Two methods may be used in setting up the problem: First, arbitrary selection to demonstrate a chosen set of conditions; second, selection by chance. Perhaps the second method does not have as much value as the first, but it does add a little zest to the work. For this purpose we use 13 pinwheels. Each dial sets up one condition. These dials are labeled fire danger class, wind direction, time fire started, part of section, section, township, range, discovery time, location time, get-away time, travel time, size of crew, and power equipment.

When the novelty wears off and the men become proficient in solving these problems under the conditions set forth thus far, we bring into play a fourteenth pinwheel, the "trouble wheel." It is divided into 32 sections, each one representing common conditions on the fire line. Some of the items are break-overs at various locations, arrival of volunteer help, loss of men, arrival of or loss of power equipment, changes in wind direction and velocity, etc. The spinning of this dial after each 15 minutes of control line is plotted gives valuable training in revising the attack to meet changing conditions.

Fire-control men may hesitate to attempt construction of the necessary scales for a device of this kind, and certainly scientists and researchers would have every right to question the accuracy of the figures we use, especially since we do not have danger stations in operation, and have not made any actual measurements of rate of spread or of line construction. We have not even defined in words the dividing line between moderate and steep slopes. Our figures are based on experience and observation plus a fair percentage of logic.

Results

Our concern as to the accuracy of the figures is not nearly as great since the device was put into use as it was at the start. We have found that when the same problem is assigned to several men there will be remarkably close similarity in the computed spread of the fire. We have plotted on paper a number of fires previously fought in the field, using the same set of conditions that occurred and the tactics employed at the time. The computed size and shape of the fire and the number of hours required to complete the control line check with such field experience within reasonably close limits. These two tests have convinced us that the scales are accurate enough for training purposes in the limited area for which they were designed.

It is recognized that for other areas the influence of fuel types, resistance to control, fatigue, and perhaps other factors may have to be considered in building the scales for rate of spread and control-line construction.

Of course, the real test of the value of this kind of training is in the results obtained in the field. Such results are hard to measure in a short period of time. We do know that when several men are given the same fire problem on paper the results in acreage lost will reflect quite accurately the amount of field experience each man has had. We know also that the results on paper improve as the man fights more "paper" fires. It is our hope that some of the paper experience and lessons will carry over into field practice.

In addition to training in suppression tactics, use of the device automatically trains the fire fighter in map reading. If the problems are set up in the area to which he is assigned, as they should be, he will gain considerable additional knowledge of his territory.

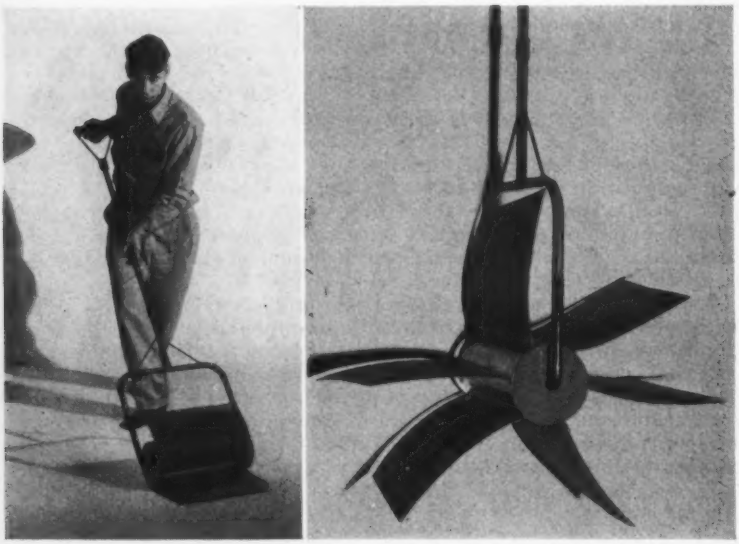
As knowledge of rates of spread and of rates of construction of control line accumulates, and as first control maps are improved, we believe that increasing use can be made of the analyzer by the dispatcher and the fire-control planner.

ROTARY FIRE MOP

PHILIP H. MURPHY

Assistant Ranger, Helena National Forest, U. S. Forest Service

This rotary fire mop is probably the only hand-operated fire-control unit that generates and applies its own flame-suppressing energy and in volume and effect simulating water under pressure. It is specially designed for the suppression of flame in grass or stubble-type fuels on relatively open fields and range, but is equally applicable to flame of this type in standing timber.



Murphy rotary mop in use (left) and close-up of mophead (right).

The device is solid and durable. With the exception of the flaps, it is of all-metal construction. No screws, bolts, or nuts are employed in its assembly; nor belts, gears, pulleys, chains, or the like that invite wear and tear. Maintenance is confined to the replacement of a flap on rare occasions. Servicing only calls for greasing of the two journal housings once annually.

How the Mop Works

The mop is easy to operate. The separate but simultaneously produced powers, obtained from tension and centrifugal force, are draft, flailing or striking, smothering or blanketing, and crushing. Flexible flaps provide a continuity of suppressive energy. The flaps are fixed to an axis so as to permit each, when in action, first to store

energy in the form of tension and then to release the tension suddenly and augment its power by centrifugal force.

The rotary mop is propelled along the flame line like a lawn mower, either forward or backward, in an upside-down or right-side-up position. It converts the simple process of walking to flame-suppressing energy, and applies it directly to the fire.

In the hands of an energetic operator it can suppress flame much faster than the conventional hand tools. Because of its caterpillar-like movement, the mop readily surmounts any obstacle equal to its own diameter. While in operation, it continually projects its own smooth tread, over which it may progress and simultaneously recover the tread after passing. The projected tread provides for its own traction and prevents skidding. Angular flap ends encourage the force of the created draft to "blow" hot ash and sparks onto the burned-over area. The tool is effective for the mop-up of punklike fuels.

Specifications

Because expansion of its principles is unlimited, no dimensional specifications apply. Model 5–15–A weighs approximately 23 pounds, and has an over-all length of about 72 inches and width of 17 inches. The 6 flaps each have a surface area of about 180 square inches, and the smothering surfaces at maximum operation are constantly at 225 square inches. Patent is pending. The cost is $24.50.

Postwar Truck.—Those who have observed military automotive equipment have been struck with the sturdiness and efficiency of the ¾-ton weapons carrier and its adaptability to fire-control work. Elsewhere in this issue appears an article on military equipment and Maj. Charles A. Rowland, the author, describes the simple conversion of the weapons carrier to a quick-attack light tanker.

The Dodge Brothers Corporation, makers of the weapons carrier, has developed a peacetime version of this vehicle and it is now in production. It is known as the 1-ton, 4 x 4, general purpose truck.

This express or pick-up type, known as Model WDX (as illustrated here) has four-wheel drive with four forward speeds, mounts a winch on the front as optional equipment and has a power take-off. Payload capacity: With 9.00 x 16 tires—3,000 pounds; with 7.50 x 16 tires—2,000 pounds.

FIGHTING FIRES WITH JEEPS

PERLE LEWIS

Forester, Clark National Forest, U. S. Forest Service

No piece of Army automotive equipment has been of greater interest than the jeep. The only jeep actually owned by the Forest Service during the war is the one described here. Hence it became a pilot model for adaptation to fire-control work. Observations of its characteristics and performance have applicability in every forested region.

On rough terrain the jeep has outstanding advantages over other automotive equipment. This has been demonstrated on the Clark National Forest.

A new Army jeep, assigned to the forest in the fall of 1942, has consistently enabled fire fighters to get to fires in considerably less time with resulting savings not only in acreage burned but in suppression costs.

In 2½ years, the jeep has traveled more than 21,000 miles in the more rugged part of the Ozarks, at elevations of 500 to 1,650 feet, with wide variations in topography and through timber stands that range from dense reproduction to old, mature trees. Here, veritable networks of old logging roads and skid trails exist, but are in advanced stages of disrepair. Heavy rains have transformed some of them into gullies, while others are almost obliterated by the growth of saplings. It has never been possible to keep more than a few main trails in a condition where regular trucks and pick-ups could be operated for fire protection. Moreover, the region is drained by numerous small creeks, bedded with gravel and sand and commonly crossed—except for the important roads—by fording.

Jeep Gets Them There

The jeep takes fire crews across terrain that is otherwise accessible only on foot or horseback. On one occasion, a fire was reported by radio to a stand-by crew with a pick-up, which was 2 miles nearer the fire than the jeep which left the ranger station at the same time. The jeep forded a creek and drove seven-tenths of a mile through the timber, arriving at the critical moment when the flames were beginning to eat into a field of dry sedge. The jeep crew stopped the fire—limiting it to 3 acres. The pick-up crew had to walk the seven-tenths of a mile through timber and came 15 minutes later than the jeep.

On another fire the ability of the jeep to get to the fire saved 2 hours of walking and 2 hours of crew time over that of a crew which used an ordinary dump truck for transportation.

In numerous instances the jeep, equipped with a 30- or 70-gallon tank of water, saved considerable time in the initial attack or mop-up because of the crew's ability to get the water right to the fire. Fitted with a 30-gallon tank, the jeep can carry two men, including the driver. This has been very effective in the initial attack. Using the 70-gallon tank limits the crew to the driver, an arrangement largely used for mop-up work.

Advantages of Jeep Over Pick-Up

Because of its construction, the jeep has numerous advantages over the pick-up. It can ford fairly deep streams because the breather pipe and oil filter openings are near the top of the motor block. Unless it is almost submerged, water cannot get into the crankcase. The generator is equipped with a hand latch which releases the fan belt when crossing streams, so that the fan will not throw water over the engine compartment. Streams two feet deep have been crossed easily.

The jeep can travel over rocky and rough country because it has more clearance than the regular pick-up or other fire trucks. Its construction gives the jeep more protection to the steering tie-rods and transmission than is found in ordinary equipment.

The jeep has proved equal or superior to any pick-up in economy of operation over similar roads. Finally, the absence of large fenders and cab makes it less liable to damage from brushy roads and deep ruts in cross country travel than other types of vehicles. The narrow tread enables the jeep to travel over roads with deep ruts, though not at high speeds.

Jeep Not a Cure-All

When all is said and done, the jeep is not, however, a cure-all for negotiating rough terrain. It has trouble following the contours of slopes with grades over 15 percent. On side slopes of this type, the jeep tends to slide downhill, often getting stuck between trees and other obstructions. This results in delay. However, it can make good time up and down hill on slopes of 20 to 30 percent.

The most serious drawback is the jeep's limited carrying capacity. It is rated as a quarter-ton, and under many conditions more men and equipment are needed for effective initial action than the jeep can carry. The answer to this problem seems to be the use of a larger vehicle of the jeep type, or two jeeps in the same action.

Revised Fire-Control Equipment Handbook.—A complete revision of the 1939 Forest Service Fire-Control Equipment Handbook was planned in late 1944, because of many recent improvements in (1) tools, equipment, and fire-control techniques developed by employees in the Forest Service; and (2) new types of power, transportation, and other equipment developed by the military organizations and private industries which were believed adaptable for effective use in forest-fire control. A national committee of representatives from the nine Forest Service regions in continental United States was convened at Washington, January 25, 1945. This committee discussed forest-fire control equipment needs and developments which had occurred since 1939, carefully reviewed the old handbook, and outlined plans and assignments to regions of contributions to be made, looking toward issue of a revised edition early in 1946.

During the latter months of 1945, much of the material for the revised handbook, in the form of rewrites of old descriptions and write-ups of new equipment items, has been reaching the Washington office. It is expected that all material for the revised handbook will have reached Washington and be edited and typed in the near future. The working committee designated by the national committee will thereafter convene at Washington to make a final review and arrangement of the material for delivery to the printer.

The handbook will be available to the public at the office of the Superintendent of Documents, Washington 25, D. C., at $1.25 per copy (tentative price).

SIMPLIFYING FIRE-FIGHTERS' MESS

H. M. WHITE

Equipment Engineer, North Pacific Region, U. S. Forest Service

In recent years there has been considerable interest in simplifying the methods of feeding fire fighters. As early as 1939, concentrated rations were developed so that suppression crews on remote sectors of the control line could maintain themselves for 3 days and save hard, time-consuming travel between the fire camp and job. Meals prepared in central kitchens have been dropped from airplanes to fire crews in efforts to eliminate the delay and expense of setting up and maintaining cooking facilities at the fire. Some of these developments and experiments are described in previous issues of FIRE CONTROL NOTES.[1] Paper dishes have been used to a limited extent in order to reduce cost and overcome the danger of sickness from improperly cleansed tinware; but until recently satisfactory paper dishes were not available, and suitable disposable knives, forks, and spoons have not yet been found.

Experiments with disposable dishes and certain types of containers for dropping prepared food to fire fighters were conducted in the North Pacific Region in the summer of 1945. The results were sufficiently encouraging to warrant use of the equipment and methods on a wider scale in 1946.

Paper Dishes

In 1944 David P. Godwin made a rather extensive investigation of disposable dishes and found three articles, a partitioned plate, round utility dish or bowl, and cup with folding handle, that appeared to meet the requirements of being waterproof, heatproof, rigid, tasteless, and inexpensive. Six thousand of each item were purchased for trial on three national forests in the North Pacific Region. Descriptions and prices are as follows:

	Cost per 1,000
Chi-net 10¼-inch blue plate, code name "Lake"	$7. 88
Chi-net 16-ounce round utility dish, code name "Nimble"	6. 36
Flared 10-ounce cup, with handle in two parts which fold to either side for nesting	9. 44

The Chi-net products were obtained from the Keyes Fiber Co., Waterville, Maine, and the cups from the C. A. Reed Co., Williamsport, Pa. The prices indicated were f. o. b. shipping point. Transportation raised the cost to slightly more than 2½ cents per single set.

A large supply of plates, utility dishes, and cups was purchased recently from Blake, Moffitt & Towne, 17 Southeast Third Avenue, Portland, Oreg., at $9.33, $7.57, and $8.07 per 1,000, respectively. Plates and utility dishes are as described above, but the cup was an 8-ounce Dixie Cup (No. 108), with the same type of folding handle as the C. A. Reed cup, and of similar quality.

Three forest supervisors reported favorably on the paper dishes, and local cooperators, who have helped on fires for years, asked why the Forest Service had not used them before. Used exclusively in lieu

[1] April 1940, p. 49; July 1940, p. 116; January 1942, p. 22.

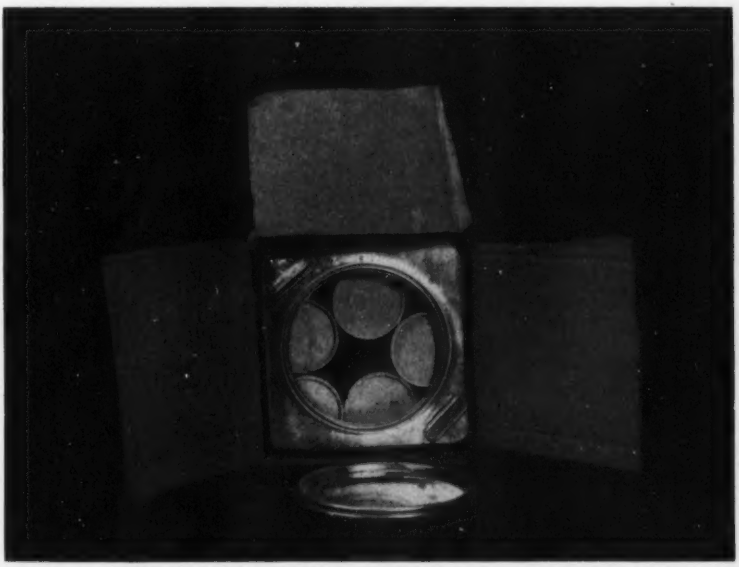
of tinware on several fires, the cooks, camp bosses, and firefighters also found them satisfactory. The plates and utility dishes withstood moisture and heat very well, but the cup was considered a little light, having a tendency to lose rigidity after the second or third filling.

Paper dishes eliminate in part the cutting of wood, heating water, and hiring flunkies to wash dishes. From initial tests it is apparent that it costs less to use paper dishes than wash the usual tinware. In addition, sanitary dishes are assured at all times. An effort will be made to obtain satisfactory paper spoons and possibly forks and knives.

So far as known, paper dishes were not dropped from airplanes on any of the forests, but they obviously have an advantage over tinware for this method of delivery.

Dropping Hot Food Containers

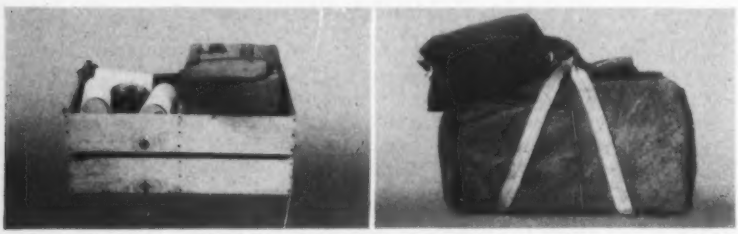
In December 1944, Floyd W. Godden, of the Intermountain Region, reported the successful use of ordinary 5-gallon gasoline cans for dropping liquids and 5-gallon friction-top honey cans for dropping prepared foods, such as scrambled eggs and bacon, cooked cereal, vegetable meat stews, etc. The cans were purchased complete with individual carboard cartons at low cost, and were left at the fire. Last spring a number of similar cans were bought in the North Pacific Region at 31 cents for the honey can and around 26 cents for the gasoline can, without cartons. Since the cartons could not be obtained, insulating and cushioning material had to be improvised.



Double-constructed carton used as insulation, 5-gallon friction-top honey can, and 1-quart cold storage locker containers. The can may be used for bulk food or to hold various foods placed in individual containers.

The honey cans were used for dropping hot meals to small crews at two fires on the Chelan National Forest. The gasoline cans were not used because a hot drink was not served, but, hot coffee or other liquid can be dropped successfully in such containers.

In one case the menu included steak, mashed potatoes and gravy, string beans, fresh milk, cinnamon rolls, and fresh fruit. While the food was being cooked the honey can, enclosed in a double-constructed cardboard carton, was set near the stove to absorb heat. The hot foods were put into 1-quart cold storage locker containers placed in the honey can in an upright position. The heated cinnamon rolls were also put in the can on top of the locker containers. The carton was then placed in one end of an orange crate, which is fitted nicely, with a 1-gallon jar of milk and fruit packed in burlap in the other end.



Left: Orange crate, with honey can in cardboard carton, and milk jar and locker containers packed in burlap. Folded burlap, not shown, was placed over the jar and locker containers. *Right:* The completed package, with parachute harness sling and silk cargo chute.

For the second fire, 4 gallons of meat balls and spaghetti in tomato sauce were put into a honey can without locker containers. The other half of the orange crate contained fresh milk, packed as before, and lettuce and tomato salad in locker containers.

In each case, the orange crate and its contents were wrapped in a piece of burlap 7 feet square and placed in a sling made of salvaged parachute harness. (The sling could have been made of rope, if parachute harness had not been available.) The packages were dropped safely with converted man parachutes. The weight of each package is not known, but undoubtedly it would have been a light load for a standard silk chute. Elapsed time in the first test was 3 hours, and in the second, 9 hours. On both occasions the cooked food was too hot for immediate consumption. There was enough meat balls and spaghetti for two meals for the crew. For the second meal the can was quickly heated over an open fire and the food was then as palatable as when freshly cooked.

In both cases, the food was dropped to smokejumpers who had individual mess kits. However, paper dishes could easily have been packed in the crate, with the milk and fruit or salad, by using less burlap packing.

THE SAND BOX AS A FIRE-CONTROL TRAINING TOOL

D. H. EULER[1]

Suppression Crew Foreman, Angeles National Forest, U. S. Forest Service

The two chief functions of the Forest Service protection force are fire prevention and fire suppression. The success or failure of our crews' performance in these functions is governed in large measure by the amount of training they get and its effectiveness.

Training in fire prevention and suppression is a technical job, and every available method and tool should be put to its fullest use. The sand table, film strips, motion pictures, and other training devices have been used effectively by the United States Army and Navy to train their personnel in the shortest time possible. Likewise in training large numbers of short-term forest protection men quickly, we have made many adaptations of new techniques to our specific purposes. Among them the sand box has proved quite successful.

The sand box is an adaptation of the Army sand table. But instead of a table holding sand for molding purposes, it is simply a mound of earth built up in the back yard of a ranger or guard station and shaped to simulate a real area with all its topographic features and various types of vegetative cover.

Angeles Sand Box

The Angeles sand box was constructed on an unused piece of ground approximately 30 feet square. Earth was piled with pick and shovel in the center and formed into every conceivable variety of ridges and

Sand box used on the Angeles National Forest to train its protection force.

[1] Appreciation is expressed to M. W. Durham, Tom Henderson, and many others whose suggestions in developing the sand box have been of great help in training personnel in fire-suppression techniques.

Close-up of sand box showing simulated topographical features.

canyons. The result was a miniature barren, mountainous wasteland, which represented roughly one township, according to scale. Roads and trails were outlined with white sand on the hillsides—dams, tunnels, and bridges adding a realistic touch. Miniature buildings simulating lookouts, guard stations, warehouses, tool caches, and settlements were constructed and spotted into the area. The miniature buildings were small blocks of wood roughly shaped and painted, as were the lookouts, with pyramid top mounted on match sticks. A small village and public camp ground represented risk and places of fire occurrence. A flood-control dam in the canyon above the village helped bring out the importance of watershed protection.

With the sand box constructed and the culture prepared and located, some suitable fuels were required to illustrate the problems to be solved by actual burning of the cover. The fire was attacked in a safe and correct manner, bringing out points of attack; line location; and methods of control, such as direct attack, backfiring, etc. Various fuels were tried, including grass, pine needles, and light brush, with heavier brush stems to represent timber and logs. The pine needle cover was the best for burning, and dry grass most suitable for flash cover type of fuel. The shorter pine needles proved slightly better than the long needles, as the latter were "stringy" and difficult to keep off the roads and firebreaks, and added to the difficulties in teaching backfiring techniques. The heavier brush stems, simulating logs, added to the instructional value by rolling into unburned areas, smoldering after the fire had passed, and the like.

Before the sand box was used, the trainees were carefully schooled in the factors affecting rates of spread, such as relative humidity, wind, fuel moisture, temperatures, use of tools and equipment, and safety measures, in order to give them background and working knowledge of fire-control techniques. A preview of the specific problem to be worked out was given before the match was applied. Each problem was followed through from start to finish, encouraging

the trainees to bring out all angles possible. After a major fire had devastated a good portion of the sand box watershed area, a fire sprinkler system was set up, the water turned on, and within a short time the erosion from a burned and an unburned area became evident.

Trainees Learn Readily

It is surprising how readily the trainees comprehend the manner in which the fire burns; the effects of various drafts; rolling materials; rates and direction of spread; and the convection of air currents created by ridges, peaks, and canyons; and other characteristics of full-sized fires. There is little hesitancy on the part of trainees to speak up when they recognize various points previously discussed in the classroom.

The problems which can be worked out on the sand box are endless. Where there is smoke, there is fire, and where there is fire the interest of the trainee is captured. Where there is interest, training is effective.

Conclusion

The development and use of the sand-box training system on the Angeles in 1944 has proven very successful and its use is encouraged and recommended. It should be stressed, however, that the sand box is not a plaything, or merely a game to pass the time away, but a definite training aid to be used in coordination with any fire-control handbook, and to study problems that have been or will be met on going fires. Further development and use of the sand box will bring improvements, and experimentation with various problems should be encouraged.

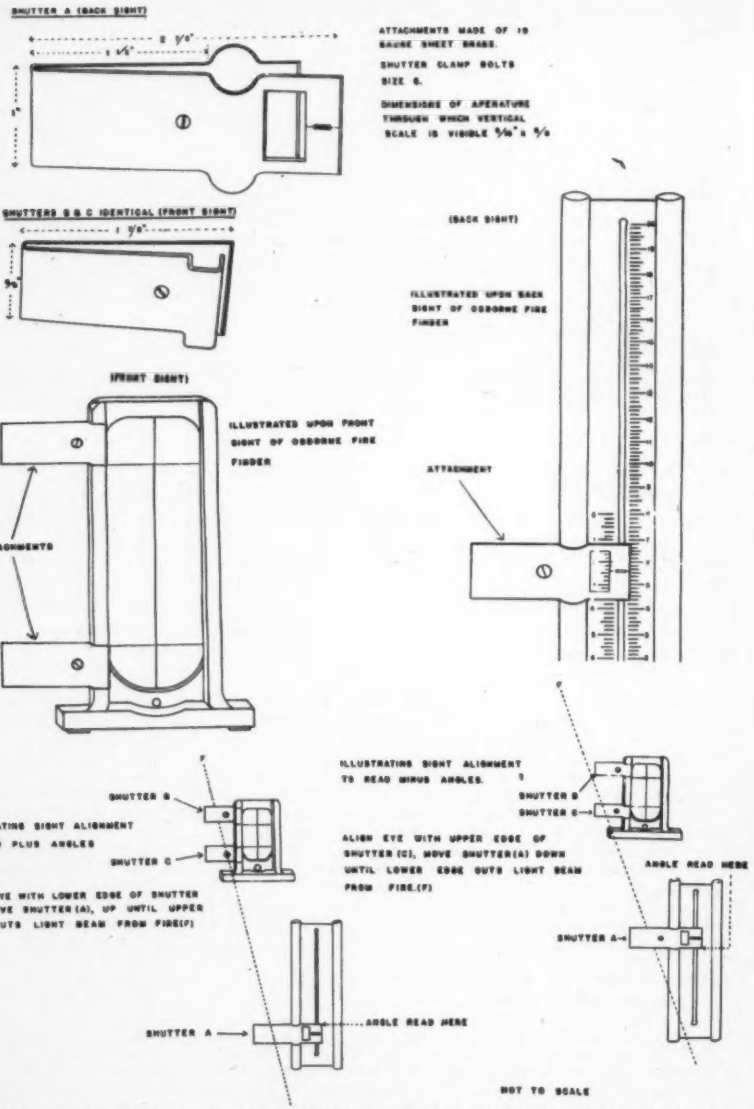
E. D. Reports.—At the meeting of the Fire Control Equipment Committee in Washington, January 1945, various forms of dissemination of equipment information were fully discussed. As a result of better organized equipment development throughout Forest Service regions, we receive, from time to time, comprehensive progress reports of items which have importance and general applicability. Because these are too lengthy and detailed to be used as articles for FIRE CONTROL NOTES, the Committee recommended that they be edited and mimeographed with multilith illustrations and distributed to field agencies.

These descriptive write-ups are labeled "E. D. Reports" and bound in a distinctive orange paper cover and numbered consecutively. So far the following have been issued:

Wescoatt Plow	E. D. Report No. 1
Michigan Line Builder	E. D. Report No. 2
Slip-On Tanker	E. D. Report No. 3
Army Jeep	E. D. Report No. 4
A Kapok Bed Bundler	E. D. Report No. 5
Ranger's Pal Plow	E. D. Report No. 6
Middle-Buster Plow	E. D. Report No. 7

These seven reports have been distributed in limited quantity to the Forest Service regional offices, the State foresters, and to certain Interior Department bureaus. It is regretted that wartime paper restrictions placed such severe limitations on quantity, but the geographic distribution is such that we believe interested readers of FIRE CONTROL NOTES will be able to borrow these listed reports from one of the offices mentioned without much difficulty. Later we hope to be able to get much fuller coverage in the distribution.—*Division of Fire Control, Washington Office.*

NIGHT ATTACHMENT FOR FOREST FIRE FINDERS


SHUTTER A (BACK SIGHT)
ATTACHMENTS MADE OF 18 GAUGE SHEET BRASS.
SHUTTER CLAMP BOLTS SIZE 6.
DIMENSIONS OF APERATURE THROUGH WHICH VERTICAL SCALE IS VISIBLE 5/16" x 5/8
SHUTTERS B & C IDENTICAL (FRONT SIGHT)
(BACK SIGHT)
ILLUSTRATED UPON BACK SIGHT OF OSBORNE FIRE FINDER
(FRONT SIGHT)
ILLUSTRATED UPON FRONT SIGHT OF OSBORNE FIRE FINDER
ATTACHMENTS
ATTACHMENT
ILLUSTRATING SIGHT ALIGNMENT TO READ PLUS ANGLES
SHUTTER B
SHUTTER C
ALIGN EYE WITH LOWER EDGE OF SHUTTER (B), MOVE SHUTTER (A), UP UNTIL UPPER EDGE CUTS LIGHT BEAM FROM FIRE(F)
SHUTTER A
ANGLE READ HERE
ILLUSTRATING SIGHT ALIGNMENT TO READ MINUS ANGLES.
SHUTTER B
SHUTTER C
ALIGN EYE WITH UPPER EDGE OF SHUTTER (C), MOVE SHUTTER(A) DOWN UNTIL LOWER EDGE CUTS LIGHT BEAM FROM FIRE.(F)
ANGLE READ HERE
SHUTTER A
NOT TO SCALE

The above drawings illustrate an attachment for the Osborne fire finder, designed by William Heckman, park ranger, Mount Ranier National Park, which permits more accurate readings of vertical angles on forest fires seen from a fire lookout during darkness. When using this item the observer, to determine a minus angle aligns his eye with the upper edge of the lower front shutter and moves the rear shutter down until the lower edge cuts the light beam from the fire. The plus vertical angle is obtained by using the lower edge of the upper front shutter and moving the rear shutter up to cut the light beam from the fire.

SCIENCE TRACKS DOWN WOODS BURNERS

HENRY SIPE

Assistant Supervisor, Cumberland National Forest, U. S. Forest Service

Man-caused forest fires have been increasing in many parts of the United States. The best way to prevent them is to find and punish the guilty persons. This, however, is usually not an easy matter. Skill is needed in finding evidence, following up clues, and locating the woods burner.

For example, a fire occurs in the woods, and a path runs through the burned area. The investigator or ranger must guess whether the fire was caused by a smoker, a hunter, or an incendiary. A match or cigarette left behind will not alone lead to a solution of the case. The identity of the traveler through the area when the fire started must be determined, and his connection with the blaze established. If the cause of a fire cannot be definitely ascertained, it is likely to go into the category of "unknown."

Many investigations of the causes of fires are delayed until clues have grown cold or been obliterated, because suppression of the fire has first priority. Often insufficient time is given to the investigation. A further difficulty is that the investigator is not versed in the scientific detection of evidence.

Tool Mark Clues

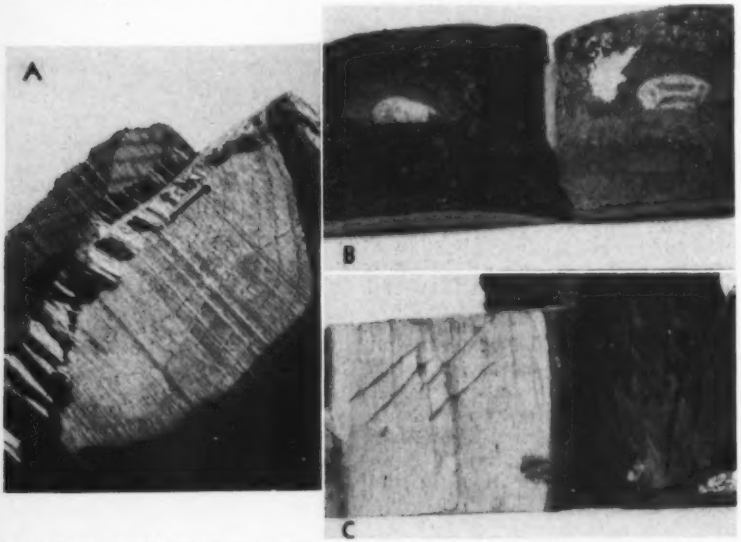
The scientific approach in determining responsibility for man-caused fires has proved quite successful on the Cumberland National Forest.

In one case, ax marks furnished the clue which led to the apprehension of a woods burner. Care must be exercised in comparing ax marks, in order to secure chips made the same way. The wood on opposite sides of a cut will differ in appearance, but close examination usually reveals certain similarities. When 10 acres of national-forest land in Estill County, Ky., were burned, a preliminary search by the fire boss failed to unearth any clues. An investigator, who arrived after dark, cross-sectioned the area thoroughly and found a moonshine still with fresh signs of a fire in the oven. Wood had been used for fuel, and ax chips showing definite nick marks were discovered. Pocketing a few chips, the investigator followed a dim trail to a house, where logs with similar marks were seen in the wood pile. Confronted with the evidence, the man of the house assumed responsibility and paid a fine. There have been no fires in that area since.

Telltale Prints

Tire, shoe, and fingerprints are among the most common and effective clues left by woods burners. A fire occurred on an old road used only by oil drillers. Tire tracks nearby showed print marks, similar to those found on a driller's truck tire. When questioned, the driller admitted being in the area the day of the fire and remembered throwing out a match near the burn. He pleaded guilty.

Another case where an ax mark provided the major clue occurred in 1943 on the Laurel district. A dead chestnut tree was found burning inside a burned area; beside it was a bundle of rags. A 6-inch hickory tree had been cut, trimmed, and used as a pry in an apparent attempt to uproot the tree; ax cuts showed identifying marks. Someone had apparently climbed a tree nearby. The investigator proceeded to the nearest residence a mile away. The man in the house said he had the flu and knew nothing of the fire except that he had seen the smoke. The investigator cut out a few chips with an ax he found at the wood pile and noted that the marks were similar to those at the fire. The man soon admitted that two boys had borrowed his ax to cut down a chestnut tree and when they returned it, had said, "We built a fire in the tree to smoke out a squirrel." The boys owned up and paid off.



A: Evidence leading to detection of a woods burner: two chips made with the same ax. *B:* Left, mark made on beech tree with suspect's mattock; right, mark found on tree on arrival at the fire. *C:* Left, cuts made with suspect's mattock; right, cuts found on burning tree.

Another type of tool-mark case occurred in 1943. Inside a burned area a large hollow beech tree was found burning. On its bark, about breast height, were marks apparently made by a blunt instrument with two kinds of edges, possibly a mattock. Footprints on a woods road, not far from the beach, led to a nearby house. The farmer living there said he and his boy had come over the road that day with a gun, mattock, and several peach tree transplants, but denied any knowledge of the fire or marks on the tree. The suspect willingly accompanied the investigators to the tree, where similar marks were made on the bark with his mattock. Sections were cut out and labeled for identification, and the farmer was told that they would be sent to the FBI Laboratory for comparison. A few days later, before a reply could be received

from the laboratory, he called at the ranger's office and confessed that his son had pounded on the tree to chase out a squirrel, failed, and set it afire as a last resort.

A thorough search will usually reveal some clue. About dark, a towerman discovered a fire a few miles from his lookout, along a dead-end road. The fire crew arrived so promptly that whoever had caused the fire did not have time to get back out of the dead-end road. Fresh tire tracks led to an isolated spot in the woods where a car was hidden. Cached nearby were 800 pounds of sugar and 100 pounds of bran meal. Inquiry in a circuit clerk's office, 75 miles away, showed that the car had been registered in a fictitious name. This information and evidence found in the woods were turned over to the Alcohol Tax Unit agents, who later discovered a large still in the burned areas and made some arrests. The fire case was filed away, and the suspects were prosecuted for violation of the liquor laws.

A Lock of Singed Hair

A very unusual determination of responsibility was made after a fire on the Red River district in 1942. An alert ranger, searching carefully, found a lock of singed hair caught in the root of a stump. Horse tracks nearby led to a farmhouse, where a horse that made similar tracks was found. The owner admitted riding through the area, but denied causing the fire. The ranger obtained a lock of the suspect's hair. Both locks were sent to the FBI Laboratory, which replied that they were similar in every major respect. Confronted with this evidence, the suspect admitted he'd been drinking and had fallen off his horse, which ran home. He had lighted a fire to warm himself and when it scorched him, jumped up, bumped his head on the stump, losing some hair, and left without extinguishing the blaze. He paid a fine in the county court.

Ballistics

The science of ballistics is of frequent use to forest-fire investigators. Many fires are caused by hunters, from campfires, cigarettes, or in smoking game out of holes or trees. Often the hunter fires his gun and discards the exploded cartridge case. Every firing pin makes a distinctive mark on the cartridge.

In a burned area in Laurel County, an exploded shotgun shell was found near a tree that appeared to have sheltered wildlife of some kind. A "twist stick," used for poking into a tree hollow, lay nearby, and burned leaves in the cavity indicated that a fire had been used to smoke out game. Inquiry showed that several persons were seen in the vicinity the day of the fire. Examination of guns narrowed the suspects to the owner of a shotgun of the same gage as the shell found in the burned area. Permission was obtained to fire the gun in his presence.

Shells from this gun, along with the exploded cartridge case picked up at the fire, were sent to the FBI Laboratory. It replied that all the shells were fired from the same gun. This definitely placed the suspect in the burned area. Confronted with this evidence, he said he had been through the region several days before the fire and had

shot at a rabbit. He showed the investigator a place outside the burn, where the alleged shot at a rabbit took place, but no exploded shell could be found there. Two persons, however, were located who had discovered the exploded shell soon after the blaze had started, when the odor of burned powder, they said, was so strong that not much time could have elapsed since it was fired. The case was brought to trial, but was lost because of certain technicalities.

Cigarette Packets

A simpler case followed a fire in Rowan County in 1943. Local farmers saw a blaze start about a minute after a stranger passed on horseback. A little girl saw the rider throw down a paper near the point at which an investigator found a "Kold" cigarette packet and a partly burned match. By means of various other clues, the stranger, a salesman who had traveled on horseback to visit a rural customer, was traced to his residence in a city 75 miles away. He admitted smoking "Kolds," but knew nothing of the fire. He readily agreed to settle the case, however, by pleading guilty before a United States commissioner.

Conclusion

Our experience in tracking down woods burners has shown that the investigator need not be an FBI agent, a superman, or a trained scientist to attain the results described. He must, however, have sufficient training or experience to know what clues to look for, how to protect and preserve evidence, what significance the clues have, and where to secure expert opinion about them. With experience and a few pieces of inexpensive equipment, an investigator can often solve cases himself, without the help of experts. He must arrive on the scene before the clues are obliterated or get cold. And he must have persistence and the will to carry on in spite of obstacles.

FLORIDA CAMP TRAILER

Division of Fire Control, Southern Region, U. S. Forest Service

Mobility is a prime essential in all Coastal Plain fire fighting. Fires spread rapidly and in order to maintain a strategic position, it is frequently necessary to move the fire camp. For this purpose a mobile 25-man unit has been developed by the Florida national forests. Built as a two-wheel weatherproofed trailer, the unit is hauled behind pick-ups or larger sized trucks. This lay-out, which serves as a traveling kitchen, can be moved up to or on the fire line, a meal served, and then carried to a selected point for future use, with a minimum of moving time.

A: Side view of Florida camp trailer. Note the 2 x 4 on top, used as a rest for one end of a ridge pole. *B:* Front view of trailer and water-tank inlets and outlets. A sawhorse is used to keep trailer tongue level. *C:* Trailer set up on sawhorse with ridge pole and center post in place in preparation for making camp. Vertical peg in 2 x 4 secures ridge pole.

The camp trailer unit is the outgrowth of several years of experience in Coastal Plain fire fighting, and its value has been proved by successful use. It can be hauled over any woods road that a pick-up can travel. It is always kept at the central fire cache, in a ready-to-go condition.

The trailer is roofed over with galvanized sheet metal and is weatherproof. The contents are secured behind a removable end gate.

A 25-man cooking outfit and forest-built stove are standard for the outfit. Food is kept in a special food box in sufficient quantities to furnish three hot meals for 25 men in addition to Army C or K rations.

A 30-gallon iron garbage can is used to heat large quantities of water over a grate or pit fire. A folding table and center post and ridge pole are regular parts of the equipment and fit inside the unit. A 10-gallon water tank, built into the trailer, is equipped with two ¾-inch water faucets and an inlet extending outside the body of the trailer at the front end.

When the tarpaulin is stretched into place over the ridge pole, a small but satisfactory shelter is provided. The trailer itself can be used as a storeroom.

Several national forests have developed similar mobile camp units with minor variations. In one instance, a small Delco light plant was built into one end of the trailer with an extension cord of sufficient length to light up the shelter, storeroom, kitchen, and immediate camp area. Such an arrangement has proven very satisfactory, as the ranger district where this trailer is used has over 100 man-caused fires per year, including many night fires.

Camp being set up, with trailer supporting ridge pole at one end.